

Delta L: An apparatus for measuring macromolecule crystal growth rates in microgravity.

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Strongly diffracting high quality macromolecule crystals of suitable volume are keenly sought for X-ray diffraction analysis so that high-resolution molecular structure data can be obtained. Such data is of tremendous value to medical research, agriculture and commercial biotechnology. In previous studies by many investigators microgravity has been reported in some instances to improve biological macromolecule X-ray crystal quality while little or no improvement was observed in other cases. A better understanding of processes effecting crystal quality improvement in microgravity will therefore be of great benefit in optimizing crystallization success in microgravity. In ground based research with the protein lysozyme we have previously shown that a population of crystals grown under the same solution conditions, exhibit a variation in X-ray diffraction properties (Judge et al., 1999). We have also observed that under the same solution conditions, individual crystals will grow at slightly different growth rates. This phenomenon is called growth rate dispersion. For small molecule materials growth rate dispersion has been directly related to crystal quality (Cunningham et al., 1991; Ristic et al., 1991). We therefore postulate that microgravity may act to improve crystal quality by reducing growth rate dispersion. If this is the case then as different materials exhibit different degrees of growth rate dispersion on the ground then growth rate dispersion could be used to screen which materials may benefit the most from microgravity crystallization. In order to assess this theory the Delta L hardware is being developed so that macromolecule crystal growth rates can be measured in microgravity.

Crystal growth rate is defined as the change or delta in crystal size (defined as a characteristic length, L) over time; hence the name of the hardware. Delta L will consist of an optics, a fluids, and a data acquisition sub-assemblies. The optics assembly will consist of a video microscope camera mounted on three axis computer controlled translation stages. The fluids assembly consists of macromolecule and precipitant reservoirs, a temperature controlled growth cell and waste container. The data acquisition is achieved by using a frame-grabber, with images being stored on a hard drive. In operation, macromolecule and precipitant solution will be injected into the temperature controlled growth cell. As macromolecule crystals grow, the video microscope camera controlled by the translation stages, will be used to locate and record images of individual crystals, returning to the same crystals at specific time intervals. The images will be stored on the hard drive and used to calculate the crystal growth rate. To prevent vibrations interfering in the crystal growth rate measurements (Snell et al., 1997) Delta L will be used in connection with the Glovebox Integrated Microgravity Isolation Technology (g-LIMIT) inside the Microgravity Science Glovebox (MSG), onboard the International Space Station (ISS).

References

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